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Presleep Cognitions in Patients with Insomnia Secondary to Chronic Pain

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This study had two primary objectives: (1) characterize the content of presleep cognitions of chronic pain patients and (2) evaluate the association between presleep cognitions and sleep disturbance. Thirty-one outpatients with benign chronic pain completed the Beck Depression Inventory, pain and sleep diaries and participated in an in vivo, *presleep thought sampling procedure for 1 week in their homes. The three most frequently reported presleep cognitions were general pain-related thoughts (36%), thoughts about the experimental procedure (27%), and negative sleep-related thoughts (26%). Stepwise multiple regression analyses found that presleep thoughts pertaining to pain and environmental stimuli were significantly associated with sleep continuity, independent from the effects of depression and nightly pain severity. Pain severity was found to be positively associated with Wake After Sleep Onset Time. These results are consistent with cognitive-behavioral models of primary insomnia and suggest the content of presleep cognitive arousal may contribute to sleep disturbance secondary to pain.*

KEY WORDS: chronic pain; insomnia; cognition; sleep; content analysis.

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INTRODUCTION

It has been estimated that between 50 and 88% of patients with chronic pain disorders have significant sleep complaints (e.g., Pilowsky *et al.*, 1985; Atkinson *et al.*, 1988; Morin *et al.*, 1998; Smith *et al.*, 2000) and that such complaints are amongst the most disabling symptoms associated with pain (Follick *et al.*, 1985). Pain patients typically report difficulty both initiating and maintaining sleep. They have also been found to have higher incidence of sleep EEG abnormalities such as reduced slow wave sleep and increased NREM α activity, which are associated with lighter, nonrestorative sleep (e.g., Wittig *et al.*, 1982; Nielsen *et al.*, 1994; Lamberg, 1999).

Despite the prevalence and severity of sleep disturbance associated with chronic pain, little is known about the causes and consequences of insomnia in this population. Of the studies that have specifically investigated the relationship between pain and sleep, pain severity, and depression have been identified as potential mediators of sleep disturbance (e.g., Affleck *et al.*, 1996; Pilowsky *et al.*, 1985; Wilson *et al.*, 1998; Morin *et al.*, 1998; Atkinson *et al.*, 1988). Work by our group (Smith *et al.*, 2000), however, suggests that insomnia in pain patients may initially occur in association with acute pain but may persist for reasons that are similar to those that account for chronic sleep disturbance in patients with primary insomnia. More specifically, we recently evaluated the factors that predict global sleep quality ratings in a sample of subjects with chronic pain. Using retrospective measures of pain severity, depressive symptom severity, daily activity level, and presleep somatic and cognitive arousal, we found that presleep cognitive arousal best predicted sleep quality and that pain severity was not a significant predictor. These results support the concept that insomnia secondary to chronic pain may be mediated by some of the same factors that are relevant for primary insomnia. That is, regardless of the etiology, chronic insomnia may be maintained by factors such as "cognitive arousal." One model of cognitive arousal suggests that the tendency to ruminate or experience intrusive thoughts directly interferes with the ability to initiate and/or maintain sleep (e.g., Hall *et al.*, 1996; Hall *et al.*, 1997; Mitchell, 1979; Gross and Borkovec, 1982). Such a perspective lends itself to the interesting possibility that "cognitive arousal" may be a common factor, but the content of presleep ruminations or intrusive thoughts may not be common to both patient groups. For example, patients with primary insomnia may ruminate about not sleeping and the consequences of poor sleep (e.g., Van Egeren *et al.*, 1983; Kuisk *et al.*, 1989; Watts *et al.*, 1994), while patients with insomnia secondary to pain may ruminate about pain or the consequences of their disability.

In the present study, we use a thought sampling procedure (1) to characterize the presleep cognitions of chronic pain patients, (2) to evaluate whether

the content of pain patient's presleep thoughts was associated with prospective measures of sleep continuity, and (3) to assess the relative contributions of presleep cognitions, pain severity, and depressive symptom severity to sleep disturbance in patients with chronic pain.

METHODS

General Procedures

Chronic pain patients were recruited from newspaper and pain clinic advertisements. Prior to enrollment, each candidate underwent a 45-min screening interview to determine eligibility. The study was conducted in two phases. All eligible patients participated in Phase I (Smith *et al.*, 2000) and a subset completed a second phase. In Phase I, the first author (M.T.S.) interviewed participants in their homes for approximately 90 to 120 min. During this session, informed consent was obtained and a variety of retrospective questionnaires were completed that addressed issues pertaining to pain, sleep history, presleep arousal, depression and sleep quality/quantity. Participants who completed Phase I received $5.00 remuneration.

In Phase II, 31 subjects completed a nightly thought sampling procedure and daily sleep and pain diaries. The thought sampling procedure involved cueing subjects on a fixed interval schedule to report presleep thoughts. The procedure was begun at "lights off" and lasted for 1 hr. Tones prompted the subjects at five time intervals to tape record their responses. Sleep diaries and nightly pain severity ratings were completed immediately upon awakening. Subjects who completed the 7-night thought sampling procedure and daily diaries were remunerated $35 for their participation. The results of Phase II (thought sampling procedure) are presented in this report.

Sample Selection

Candidates were recruited from newspaper advertisements and/or from flyers distributed at pain treatment clinics in the San Francisco Bay area. Advertisements indicated that subjects were needed for a study of chronic pain. The advertisements specified that all patients with chronic pain were potential candidates and that participants would be eligible for up to $35 remuneration. Eligible patients were required to be between 18 and 70 years of age and currently receiving outpatient treatment for a pain condition. Only subjects with chronic pain conditions (6 months or greater in duration) were recruited. Patients who reported difficulty hearing, alcohol or substance abuse problems (current or within the last 6 months), severe memory

problems, or a major medical condition unrelated to the primary pain complaint, or who were in treatment for a psychiatric disorder other than depression secondary to chronic pain, were ineligible for the study. Subjects who reported major symptoms of intrinsic sleep disorders other than insomnia were also excluded (e.g., sleep apnea, periodic limb movement disorder, narcolepsy, and/or circadian rhythm disorders).

Psychometric Measures

Participants completed seven survey/questionnaire instruments. These included a demographic form, a pain and sleep history questionnaire, the Pittsburgh Sleep Quality Index (PSQI) (Buysse *et al.*, 1989); a daily sleep diary, a nightly pain severity rating, the Beck Depression Inventory (BDI) (Beck *et al.*, 1961, 1988) and a thought sampling reactivity questionnaire (TSRQ). Provided below are details regarding the primary measures (sleep dairies, pain measures, and reactivity questionnaire).

The daily sleep diary is a 12-item self-report questionnaire completed in the morning that elicits quantitative and qualitative information about the participant's sleep the night before. The diary was adapted from a measure developed for use with chronic pain patients by Haythornthwaite and colleagues (1991) and a sleep diary developed by Morin (1993). Daily sleep diaries are a widely used index of subjective sleep quality and have demonstrated adequate reliability and validity (e.g., Lichstein and Riedel, 1994; Coates *et al.*, 1983; Monk *et al.*, 1994). The diary takes less than 5 min to complete and contains items that require the participant to estimate time to bed (TTB), time of "lights out," latency to sleep, number and duration of nocturnal awakenings, time out of bed after final awakening (TOB), and subjective sleep quality (5-point Likert scale). In addition, patients were required to report daytime napping, medication/alcohol usage, and caffeine consumption. From these questions, eight quantitative variables related to sleep continuity were calculated: sleep latency (SL; estimated time to fall asleep after turning out the lights with the intention of going to sleep), frequency of nightly awakenings (FNA; estimated number of awakenings after sleep onset prior to final awakening), wake time after sleep onset (WASO; total duration of nightly awakenings), duration of early morning awakenings (EMA; time in bed after final awakening prior to getting out of bed), total wake time (TWT = SL + WASO + EMA), time in bed (TIB = TTB − TOB), total sleep time (TST = TIB − TWT), and sleep efficiency (SE = TST/TIB × 100). The final sleep diary variables were averaged over the number of nights of participation. Daily sleep diaries were selected, because they involve multiple

sampling of sleep parameters over time ("prospective") and arguably provide a more accurate and reliable estimate of sleep continuity compared to global, one-shot measurement strategies ("retrospective").

The Nightly Pain Severity Rating (NPSR) is a 6-point rating scale developed by Melzack (1975) (0 = no pain, 1 = mild, 2 = discomforting, 3 = distressing, 4 = horrible, 5 = excruciating). Melzack and Torgerson (1971) demonstrated that the descriptors assigned to each of the numbers in the scale reflect equal scale intervals and therefore serve as appropriate anchors for measuring overall pain severity. Kerns *et al.* (1988) demonstrated the reliability and validity of this scale in a heterogeneous population of pain patients. This questionnaire was appended to the sleep diary and was completed each morning as a measure of the previous night's pain severity. The NPSR was completed in the morning to minimize the possible influence of pain ratings on presleep thought content. The NPSR variable derived in this study was averaged over nights of participation.

The Thought Sampling Reactivity Questionnaire (TSRQ) is a three-item questionnaire designed by the authors to assess participant reactivity to the thought sampling procedure. This questionnaire was appended to the sleep diary and was completed each morning. Participants were asked to rate how disruptive the previous night's procedure was to their overall sleep quality using a 5-point Likert scale (1 = very disruptive to 5 = not disruptive at all). Additionally, participants rated how typical their presleep thoughts were compared to their usual presleep thoughts (1 = very unusual of my presleep thoughts to 5 = very typical of my presleep thoughts). Subjects also rated how representative their sleep was compared to usual (1 = much worse than average to 5 = much better than average).

Setting and Equipment for Thought Sampling Procedure

The thought sampling procedure was conducted in the participants' own bedroom. Two commercial tape recording/playing devices were selected for their ease of use: a Sony tape recorder (TCM-359V) and a General Electric Cassette Recorder (GE 3-5025A). The GE recorder delivered the stimulus prompts. It has a variable volume control and a silent stop feature so that when the tape plays out, the device will stop without making a sound that could be disruptive to sleeping participants. The Sony recorder also has a silent stop feature and was used to record subject's verbal responses. The recorder was turned on at "lights off" and was allowed to run continuously over the 1-hr monitoring interval. Subject's responses were recorded via the Sony's internal flat microphone.

Subjects were prompted to report their thoughts by a soft, low-pitched (approximately 100 HZ, 1 sec) tone. The first tone sounded at 3 min; the second, third, fourth, and fifth tones sounded at 10, 20, 30 and 50 min, respectively. The first tone sounding at 3 min ensured that most sleepers would report at least one presleep thought sample per night in response to the stimulus tones. The fourth and fifth tones (sounding at 30 and 50 min) provided thought samples from participants who were experiencing at least moderate difficulty falling asleep. All participants underwent a 30-min training to ensure that they (1) correctly completed the various questionnaires, (2) understood how to operate both the tape recorders, and (3) selected a volume for the prompt tones that was loud enough to be perceived but minimally intrusive. The first author (MTS) contacted participants on the second day of the procedure to answer any questions and facilitate proper adherence.

To make the thought sampling procedure as unobtrusive as possible and to decrease experimental demand factors, participants were given four response options (Van Egeren *et al.*, 1983) and (Hurlburt, 1979): (1) to report their thoughts freely, (2) to state, "None of your business" (allowing participants to decline disclosure of potentially embarrassing thoughts), (3) to state "I don't remember" if they were aware of thinking but could not remember their thoughts, and (4) to state "don't know" if participants were not aware of any thoughts.

To help ensure that the diaries were completed correctly and to monitor further proper adherence to the procedure, the questionnaires and the previous night's tape containing the recorded thought samples were mailed back to experimenter each day for review (Lacks *et al.*, 1983). Participants were supplied with stamped, addressed envelopes to facilitate this process.

Content Analysis

Presleep thought content was analyzed by transcribing the verbal reports for each night of the thought sampling procedure. Data were transcribed by a medical secretary and the first author (M.T.S.). Content categories were established by reading the thought samples and identifying thematic content categories that emerged frequently from the data. Thirteen content scales were initially developed and evaluated independently by two trained raters. Initial content categories were Thoughts About the Procedure (TAP), Environmental Stimuli (ES), Pain Sensation (PS), Pain-Related Coping Strategies (PCS), Other Pain-Related Thoughts (OP), Thoughts About Somatic Conditions/Health (TASH), Negative Sleep-Related Thoughts (NST), Positive Sleep-Related Thoughts (PST), Dream-like Mentation (DLM),

Thoughts About Friends/Family (TAF), Planning Future Events (PFE), Work-/School-Related Thoughts (W/ST), and Daytime Review (DTR). Not all content categories were mutually exclusive. For example, a response could be coded as both work-/school-related and planning for future events. The three pain-related content categories were mutually exclusive, such that they could be consolidated into a general pain-related thoughts category to simplify the analyses. A standardized Pre-Sleep Cognitions Coding Manual was developed, which describes in detail the instructions and rules used to define and code the content categories (this manual is available upon reqest). As indicated previously, three additional content categories were included in the coding manual: none of your business (NYB), don't know (DK), and don't remember (DR). Since less than 3% of the responses contained these content categories, they were dropped from the analyses.

Two students with bachelor's degrees in psychology who were blind with respect to patient status (e.g., sleep quality, depression/pain severity) and the study hypotheses were paid as research assistants to code the frequency of responses falling into each content category. Each response was coded for as many or as few categories as were applicable. Research assistants were trained for approximately 8 hr using the coding manual to 90% agreement on a sample of five participant reports. Percentage agreement was used to measure interrater reliability (total number of agreements/total number of agreements + total number of disagreements). Interrater reliability between the pair of judges for the entire set of 659 reports for all content categories ranged from 91.7 to 97.4%. A third rater (M.S.S.) served as a final judge and used the coding manual to settle any coding discrepancies between the two raters.

Derivation of Content Variables. Content category variables were calculated by summing the frequency of each content category per night divided by the total number of tones responded to each night, averaged over the total number of nights participated (e.g., [(frequency of PS night1/number of tones responded to Night1) + (frequency of PS Night2/number of tones responded to Night2) + ...] /[total number of nights participated]). By this method, the maximum score one could earn was 1 and the minimum was 0. A score of 1 would reflect the presence of this particular thought in each response for every night of participation, whereas a score of 0 would reflect an absence of this thought in each response for every night of participation. For example, if a participant's pain sensation content score (PS) equaled .75, this would indicate that on an average night, 75% of the patient's responses contained thoughts about pain sensation relative to the other content categories. Proportions were used to control for differences in frequencies as a function of the number of individual responses (Van Egeren *et al.*, 1983).

General Strategy for Analyses

As indicated previously, this study had two primary objectives: first, to describe the content of pain patients' presleep cognitions and, second, to evaluate whether presleep thought content is associated with sleep parameters. Descriptive statistics were used to characterize the sample in terms of sleep continuity and quality, and a content analysis was conducted on the thought sampling data to describe the content of the nightly thought reports. Bivariate and multivariate correlation techniques were used to evaluate the relationship among presleep thought content variables, pain severity, depressive symptom severity, and average daily sleep diary measures of sleep continuity.

Strategy for Multivariate Analyses

Selection of Criterion Variables (Dependent Variables). To evaluate whether presleep thoughts were related to sleep continuity, selected thought content category variables, average Nightly Pain Severity Ratings, and the Beck Depression Inventory Total Score were regressed in a stepwise fashion onto two major criterion variables, i.e., sleep latency (SL) and wake time after sleep onset (WASO). Multiple regression analyses were limited to two criterion variables to minimize Type I error and because they are the primary variables associated with sleep onset and sleep maintenance insomnia. We also chose to include WASO as a major criterion to explore, in a preliminary way, the possibility that presleep cognitions may reflect neurocognitive processes that not only delay sleep onset but influence sleep continuity throughout the night.

Selection of Predictor Variables (Independent Variables). As noted previously, three types of predictor variables were used in this analysis: thought content categories, average pain severity ratings, and depressive symptom severity ratings. The selected content categories included thoughts about pain, the procedure, sleep, and the environment. These four content areas were selected based on (1) the frequency of endorsement within the present sample (see Table II) and/or (2) there being a precedent within the insomnia literature for the relevance of the variable [e.g., negative thoughts about sleep and thoughts related to the sleep environment (Van Egeren *et al.*, 1983; Watts *et al.*, 1994; Kuisk *et al.*, 1989)]. Nightly pain and depressive symptom severity ratings were selected as predictors because both of these variables have been found to be associated with sleep disturbance in pain patients (e.g., Haythornthwaite *et al.*, 1991; Affleck *et al.*, 1996; Wilson *et al.*, 1998). The stepwise regression procedure was used to evaluate the relative importance of

each variable in explaining variation in the criterion (Darlington, 1990). We did not utilize a predetermined, fixed order for selection of predictor variables. Rather, all of the predictors were allowed to "compete for variance," with the step 1 predictor having the highest correlation with the criterion.

Subjects. Thirty-one subjects with nonmalignant chronic pain participated in the thought sampling procedure and the prospective (daily diaries) assessment of sleep continuity. The mean age was 42.7 ± 10.2, and 67% of the sample was female. Seventy-one percent were Euro-American, 52% had bachelors degrees or higher, and 23% were on disability. Twenty-nine percent reported working either full or part-time. Twenty-three percent were married.

Clinically, the sample was comprised of patients with upper or lower back pain (55%), pain from rheumatoid or osteoarthritis (6%), pain from fibromyalgia (7%), and other musculoskeletal pain (32%). The median duration of pain was 5 years (mean = 9.66 ± 10.59 years; range = .75–49 years). The median number of days a year confined to bed at least half of the day due to pain was 30 days (mean = 75 ± 89 days range = 0–300 days). The mean Pittsburgh Sleep Quality Index Global score was 11.19 ± 4, indicating that the sample consisted of poor sleepers (Buysse, 1989). The mean Beck Depression Inventory Total Score was 15.5 ± 6.5, indicating that the sample reported a mild to moderate degree of depression. Forty-two percent of the sample reported taking narcotics, 26% reported taking nonsteroidal anti-inflammatories, 19% reported taking antidepressants, 10% reported taking muscle relaxants, and 9% took sedative hypnotics on a regular basis. Prior work by our group with the entire Phase I sample ($N = 51$) did not find differences comparing patient groups by nightly medication usage (e.g., use of hypnotics, sedative antidepressants, muscle relaxants, or narcotics vs. no use), pain condition, and gender on measures of sleep quality and presleep arousal (Smith *et al.*, 2000).

RESULTS

Sleep Continuity and Quality

Table I presents the descriptive statistics for the eight variables derived from the sleep diaries. On average, patients reported taking about 44 min to fall asleep, about 82 min of time awake in bed (WASO + EMA), and an average sleep efficiency of 71% (total sleep time/total time in bed). Mean ratings on the 5-point sleep quality scale indicate that subjects reported their sleep quality as between "neither poor nor good" and "poor" (M = 2.73, SD =.64).

Table 1. Descriptive Statistics for Daily Sleep Diary Variables ($n = 31$)

Variable	Mean	Range	SD
Sleep latency (SL)	43.89	11.00–111.43	22.26
Frequency of nightly awakenings (FNA)	2.26	0.29–5.00	1.19
Wake time after sleep onset (WASO)	41.80	1.29–227.50	40.97
Early morning awakening (EMA)	40.47	0.00–141.43	35.80
Total sleep time (TST)	391.43	245.71–538.57	74.28
Total wake time (TWT)	126.17	31.71–263.33	61.83
Sleep efficiency percentage (SE)	71.00	36.0–95.00	14.00
Sleep quality[a]	2.73	1.71–4.29	.64

Note. SOL, WASO, EMA, and TWT—time in minutes; FNA—number of nightly awakenings (not including final awakening); EMA—duration of early morning awakening (time in bed after final awakening prior to getting out of bed); TWT—SOL + WASO + EMA; SE—[(TST/time in bed) × 100].
[a]Higher scores indicate better sleep quality (1 = very poor sleep quality, 5 = very good sleep quality).

Reactive Effects of the Thought Sampling Procedure

As indicated in the methods section, the thought sampling reactivity questionnaire was used to assess subject's reactivity to the procedure. This instrument contained three 5-point Likert scales: one on the "disruptiveness" of the procedure, one regarding whether the presleep cognitions were "typical," and one on whether the subject's sleep that night was "representative" of an average night's sleep. The mean rating on the "disruptive" scale was 3.6 ± 0.79, where a scale score of 4 corresponds to "minimally disruptive." The mean rating on the "typicality" scale was 3.3 ± 0.6, where a scale score of 4 corresponds to "typical" presleep thoughts. The mean rating on the "representative" scale was 2.8 ± 0.5, where a scale score of 3 corresponds to an average night's sleep. The combination of these measures suggests that the procedure was minimally intrusive and that the sample of presleep cognitions was typical and derived from what patients perceived as "typical" sleep. To determine formally whether the procedure interfered with sleep onset, the mean sleep latency for the first night of the protocol (when it would be expected that subjects would be the most reactive) was compared to the 7-day average. The mean sleep latency for the first night was 46.8 ± 26.1 min, and the 7-day mean was 43.9 ± 22.3 min. This 3-min difference was not significant ($t = -.76$, df = 30, $p = .45$).

An alternative measure of reactivity might be the frequency of presleep thought contents pertaining to the procedure. We found that a relatively high percentage of thoughts was related to the procedure (26%). Correlation analysis indicated that the proportion of thoughts pertaining to the

Table II. Descriptive Statistics for Presleep Thought Content Categories ($n = 31$)

Content category	Mean[a]	Range	SD
General Pain-Related Thoughts [(GPS) = PS + CM + OP][b]	.36	.00–1.09	.33
Thoughts about the Procedure (TAP)	.27	.00–1.00	.25
Negative Sleep-Related Thoughts (NST)	.26	.00–.88	.23
Daytime Review (DTR)	.15	.00–.46	.14
Thoughts About Friends/Family (TAF)	.14	.00–.45	.12
Positive Sleep-Related Thoughts (PST)	.13	.00–.74	.19
Planning Future Events (PFE)	.13	.00–.30	.10
Thoughts About Somatic Conditions/Health (TASH)	.12	.00–.31	.10
Environmental Stimuli (ES)	.10	.00–.53	.13
Dream-like Mentation (DLM)	.10	.00–.56	.15
Work-/School-Related Thoughts (W/ST)	.08	.00–.32	.10

[a] The group's nightly proportion of thought content categories by number of responses averaged across total number of nights of participation.

[b] The General Pain-Related Thoughts category is aggregated from the three mutually exclusive pain categories: Pain Sensation (PS; 22%), Other Pain-Related Thoughts (OP; 8%), and Pain-Related Coping Strategies (PCS; 6%).

procedure was not significantly associated with any of the sleep variables or with any of the items from the reactivity questionnaire. This suggests that although participants reported a fair number of thoughts about the procedure, as would be expected, they did not consider these thoughts to be intrusive or interfere with their sleep. In reviewing the individual responses containing thoughts about the procedure, the vast majority of these responses reflected participant's comments that they had heard the stimulus prompts, rather than reporting negative thoughts about the procedure itself.

Description of Presleep Thought Content

Six hundred fifty-nine distinct reports were obtained from 31 participants. Each report was the participant's entire verbal response to a tone and often included multiple thoughts. The mean number of nights of participation was 6.06 (SD = 1.29; range, 2–7). The mean number of tones responded to each night was 3.45 (SD = .94; range, 1.14–4.71). Table II presents the mean proportion of thoughts rated for 11 of the content categories. Means reflect the overall frequency of thoughts per category per night for the entire sample. The most frequently reported presleep thoughts were related to pain (GPT; 36%), the experimental procedure (TAP; 27%), and negative thoughts about sleep (NST; 26%). The frequency rates for these categories did not differ significantly from each other ($p < .05$).

An example of the general pain category is "Well today was another day challenged with . . . another bout of some vaguely explainable excruciating pain." An example of

the procedure category is "I heard the beep and I was thinking about what I would say next when the beep went off." An example of the negative thoughts about sleep category is "I can't sleep. I really wanted to be able to fall asleep."

Bivariate Interrelationships Among Presleep Thought Content, Depressive Symptom Severity, Pain Severity, and Sleep Continuity

Before conducting multivariate analyses to determine the relative contributions of thought content, depression, and pain severity in explaining sleep continuity disturbance, a bivariate analysis was conducted between these potential predictors and criteria. Table III presents the Pearson's *r* correlations between the variables. As indicated in Table III, several moderate positive relationships were found among sleep continuity, thought content, pain, and depression severity variables. In considering the relationships between the potential predictors of sleep continuity, depression severity was positively associated with pain severity. Pain severity was positively associated with the proportion of general pain-related thoughts. Because these relationships were moderate, they are not likely to pose multicollinearity problems when used as predictors in the multivariate analyses.

Table III. Pearson's *r* Correlation Matrix Among Thought Content, Depression Severity, Nightly Pain Severity, and Sleep Continuity

Variable	1	2	3	4	5	6	7	8	9
1. General Pain-Related Thoughts	—	.26	−.29	−.06	.16	.38*	.39*	−.13	.07
2. Negative Sleep-Related Thoughts		—	−.21	.33	.22	.14	−.16	−.09	−.11
3. Environmental Stimuli			—	.02	−.02	−.29	−.06	.53**	−.15
4. Thoughts About the Procedure				—	.13	−.05	.13	−.16	−.05
5. Beck Depression Inventory Total Score					—	.45**	.20	.12	.42*
6. Nightly Pain Severity Rating						—	.10	.51**	.19
7. Sleep Latency							—	.06	.36*
8. Wake Time After Sleep Onset								—	−.11
9. Early Morning Awakening Time									—

Note. $^{*}p < .05$; $^{**}p < .01$. None of the relationships are significant when Bonferroni corrections are made to account for multiple comparisons.

Multivariate Analyses Between Predictors and Sleep Continuity

Presleep Thought Content, Pain Intensity, Depressive Symptom Severity, and Sleep Latency. To evaluate what factors were associated with sleep latency (SL), four thought content categories, the BDI total score, and the Nightly Pain Severity Ratings were regressed onto sleep latency in a stepwise fashion. The four content categories were General Pain-Related Thoughts, Thoughts About the Procedure, Negative Sleep-Related Thoughts, and Thoughts About Environmental Stimuli. As shown in Table IV, only the General Pain-Related Thoughts category significantly predicted sleep latency [$R = .38$, $F(29,1) = 5.12$, $p = .03$]. The relationship was positive and accounted for 15% of the overall variance. Thus, patients who reported a greater proportion of presleep cognitions pertaining to pain tended to report longer sleep latencies. Pain severity, depressive symptom severity, and the remaining three presleep thought content areas were not associated with sleep latency.

Presleep Thought Content, Pain Intensity, Depressive Symptom Severity, and Wake Time After Sleep Onset. As with the multiple regression analysis for sleep latency, four thought content categories, Nightly Pain Severity Ratings, and the BDI Total Score were regressed on to wake time after sleep onset (WASO). As can be seen in Table IV, presleep thoughts about Environmental Stimuli and Nightly Pain Severity Ratings were the only significant

Table IV. Summary of Stepwise Multiple Regressions of Selected Thought Content Categories, Pain Intensity, and Depression Severity on Sleep Latency and Wake Time After Sleep Onset ($n = 31$)

Step	Predictor variable	Mult. R	Model R^2	Partial R^2	B	β	t	p
	Sleep latency[a]							
1	General Pain-Related Thoughts	.39	.15	.15	25.8	.39	2.3	.03
	Overall multiple $R = .39$; overall SE = 20.87; overall $F(29,1) = 5.12$, $p = .03$							
	Wake time after sleep onset[b]							
1	Environmental Stimuli	.53	.28	.28	172.35	.53	3.38	.002
2	Nightly Pain Severity Rating	.67	.45	.17	17.74	.42	2.90	.007
	Overall multiple $R = .67$; overall SE = 31.49; overall $F(28,2) = 11.38$, $p = .0002$							

[a] Variables not found to be significant to the model: Negative Sleep-Related Thoughts, Beck Depression Inventory Total Score, Environmental Stimuli, Nightly Pain Severity, and Thoughts About the Procedure.

[b] Variables not found to be significant to the model: General Pain-Related Thoughts, Thoughts About the Procedure, Beck Depression Inventory Total Score, and Negative Sleep-Related Thoughts.

predictors of wake after sleep onset time. Environmental Stimuli and Nightly Pain Severity Ratings were both positively associated with wake after sleep onset time (i.e., more thoughts about the sleep environment and more severe self-reported pain were associated with more time spent awake after sleep onset). When taken together, these two variables explained approximately 45% of the overall variance in WASO [multiple $R = .67$, $F(28,2) = 11.4$, $p = .0002$]. The Environmental Stimuli content category independently explained about 28% of the overall variance and Nightly Severity Ratings predicted approximately 17% of the variance.

DISCUSSION

This study sought (1) to characterize the presleep cognitions of chronic pain patients, (2) to evaluate whether the content of pain patients' presleep thoughts was associated with prospective measures of sleep continuity, and (3) to assess the relative contributions of presleep cognitions, pain severity, and depressive symptom severity to sleep disturbance in patients with chronic pain. It was found that the three most frequent presleep cognitions were related to pain (36%), the experimental procedure (27%), and negative thoughts about sleep (26%). Ruminations of these sort predicted sleep initiation and maintenance problems. Specifically, it was found that general pain-related thoughts predicted sleep latency and thoughts about environmental stimuli predicted wake after sleep onset time. In addition, pain severity also predicted wake after sleep onset time. Depressive symptom severity was not associated with prospectively measured sleep latency or wake after sleep onset time.

Presleep Thought Content

As discussed previously, an investigation by our group found that "cognitive arousal," as opposed to pain and depressive symptom severity, best predicted sleep disturbance (Smith *et al.*, 2000). We interpreted this finding to mean that rumination may be an important feature of both primary insomnia and insomnia secondary to chronic pain. Further, we speculated that although "cognitive arousal" may be a common factor, the content of what patients think about prior to sleep is likely to differ. That is, patients with primary insomnia may ruminate about not sleeping and the consequences of poor sleep (e.g., Watts *et al.*, 1994; Van Egeren *et al.*, 1983), while patients with insomnia secondary to pain may ruminate about pain or the consequences of their disability. This speculation was partially supported by the results of the

thought sampling procedure. It was found that subjects in this sample frequently thought about their pain condition prior to sleep onset. The patients in this sample, however, also had frequent thoughts about the procedure and about their sleep difficulties. To a certain extent this is not surprising. The study was clearly focused on pain, involved a procedure that was not part of a normal evening's routine, and required subjects with sleep difficulties to monitor their sleep closely. It would therefore be expected that thoughts about pain, the procedure, and negative sleep-related concerns would be among the most commonly reported thought contents, and this was the case. This issue notwithstanding, one would also expect that the three content areas would not be equally weighted with respect to frequency and that general thoughts about pain would clearly predominate. This was not the case, as the general thoughts about pain category was only 9 to 10% more frequent than thoughts about the procedure and negative sleep-related thoughts, respectively. No significant differences were noted in the frequency of these three categories of cognition. Thus, it may be argued that cognitive arousal is a primary feature of insomnia and that, regardless of etiology, negative sleep-related thoughts are common to both primary insomnia (e.g., Van Egeren *et al.*, 1983; Watts *et al.*, 1994) and insomnia secondary to pain. What remains to be considered is whether negative sleep-related thoughts actually predict sleep continuity in patients with chronic pain.

Presleep Thought Content and Sleep Continuity

Given that thoughts about pain and negative thoughts about sleep occurred at relatively equal frequencies, one might expect that both would be negatively associated with sleep continuity. This was not the case. It was found that general pain-related thoughts predicted sleep latency and that thoughts about environmental stimuli predicted wake after sleep onset time. The fact that only general thoughts about pain predicted sleep latency suggests that, while cognitive arousal may be a common factor, "what patients think about" also appears to contribute to sleep initiation problems. This finding is particularly interesting given the relatively moderate overlap in variance (14%) between nightly pain severity and presleep thoughts about pain. This suggests that increased thoughts about pain is not simply explained by increased perceptions of pain severity. Thus, it may be said that patients with primary insomnia ruminate about not sleeping and the consequences of poor sleep, and this appears to contribute to their difficulties initiating sleep (Van Egeren *et al.*, 1983; Watts *et al.*, 1994). Patients with insomnia secondary to pain, however, ruminate about pain and the consequences of their disability, and this appears to contribute to their difficulties initiating sleep.

This diathesis may be understood from the perspective that rumination and worry are cognitively arousing to the extent that they bear on issues of import to the individual. For the patient with primary insomnia the emotionally salient issue, and the thoughts that are most likely to be arousing, pertains to sleep. For the chronic pain patient, however, the emotionally salient issue pertains to pain. These data, and this interpretation, may be taken to suggest that rumination is the primary driving force behind chronic sleep onset insomnia. This concept is consistent with a model of cognitive arousal which holds that the tendency to ruminate or experience intrusive thoughts directly interferes with the ability to initiate sleep (e.g., Hall *et al.*, 1996, 1997; Mitchell, 1977). This concept is not consistent with newer theories (Perlis *et al.*, 1997a; Bonnet and Arand, 1997), which do not feature cognition as the primary mediator of sleep onset insomnia but, rather, focus on the biological processes that may underlie cognitive arousal. For example, the neurocognitive model of insomnia (Perlis *et al.*, 1997a) suggests that, in *chronic insomnia*, "what people think about" is secondary to conditioned cortical arousal.

Two interpretations are possible that may bridge the apparent gap between purely cognitive and more neurobiological theories. First, cortical arousal may lead to the activation of cognitive schema that are consistent with the intensity of the cortical activation. Thus, in patients with primary insomnia, conditioned arousal is likely to lead to affectively charged thoughts about sleep. In patients with insomnia secondary to chronic pain, conditioned arousal is likely to lead to affectively charged thoughts about pain. Alternatively, there may be a feed forward–feedback process such that cortical arousal gives rise to thoughts which are affectively charged, and such thoughts may, in turn, increase the underlying cortical arousal. The relative importance of these two factors in either primary insomnia or insomnia secondary to chronic pain remains to be determined.

The finding that thoughts about the sleep environment predicted wake after sleep onset time but not sleep latency is interesting. In primary insomnia, thoughts about the sleep environment have been found to predict sleep initiation problems (Van Egeren *et al.*, 1983). Perhaps, as was the case with negative sleep-related thoughts, thoughts about the sleep environment are secondary to (and therefore less arousing) the patient's primary concerns about pain. If this is the case, however, one must address why, after sleep onset, such thoughts about environmental stimuli become primary. One possible interpretation is that while pain perception may be attenuated during some stages of sleep (Nielson *et al.*, 1993; Schmidt, 1978; Lavigne *et al.*, 2000) processes related to nociception result in a shallowing of the sleep state (Moldofsky *et al.*, 1975, 1976), which in turn makes the individual vulnerable to awakenings from what would otherwise not be perturbing

environmental stimuli (Perlis *et al.*, 1997b). This assumes, however, that our measure of presleep thoughts about environmental stimuli acted as a proxy for a variable that was not measured: thoughts about environmental stimuli during wake after sleep onset intervals. It may also be the case that thoughts about environmental stimuli reflect a heightened level of sensory processing/focus, which is associated primarily with sleep maintenance disturbance rather than sleep onset problems for reasons that remain unclear. It might be that patients who are internally preoccupied with their pain condition are predisposed to sleep initiation problems because of sleep interfering effects of such rumination, whereas patients who are more externally focused on environmental factors are more predisposed to sleep maintenance difficulty. Both of these styles might be construed as two ways of coping with pain, i.e., ruminating about the problem (Internal) versus attempting to distract oneself from pain (External). These speculations would be interesting to explore in future research.

Pain Severity and Sleep Continuity

In the present study we found that pain severity was associated with middle insomnia. This finding is consistent with previous research, which shows that pain severity, while not necessarily the primary predictor of sleep disturbance, is nonetheless a significant factor (e.g., Haythornthwaite *et al.*, 1991; Affleck *et al.*, 1996; Pilowsky *et al.*, 1985; Wilson *et al.*, 1998; Atkinson *et al.*, 1988). The fact that pain severity did not predict sleep latency difficulties, and was not the primary predictor of wake time after sleep onset, suggests that the perception of pain may not be the central consideration. As argued above, one possibility is that pain may result in a form of sleep that is easily disturbed. Another possibility, as discussed in previous work by our group (Smith *et al.*, 2000), is that acute pain conditions may precipitate the development of insomnia but that chronic insomnia is maintained by factors that apply equally to primary insomnia and insomnia "secondary" to chronic pain. Maintaining factors include a variety of maladaptive behaviors that are thought to lead to conditioned somatic and/or cortical arousal (e.g., Spielman *et al.*, 1987a, Perlis *et al.*, 1997a; Morin, 1993).

Finally, it is important to consider why it is that we did not detect an association between pain severity and sleep continuity in our prior study. This may have occurred for one of several reasons. First, in the present study, we did not use a global measure of sleep quality (PSQI; Global Severity) but instead allowed for sleep quality to be construed in terms of two specific dimensions (i.e., sleep latency and wake after sleep onset time). This may have, in turn, allowed for us to observe "interaction effects" that might otherwise

have been averaged out. For example, if global assessments of sleep quality are based primarily on patient assessments of how easy it is for them to fall asleep (e.g., Cragg *et al.*, 1999) and if, as we found in this study, sleep onset difficulties are associated primarily with "cognitive arousal" in the form of ruminative thoughts about pain, then global assessments of sleep quality would be expected to be correlated primarily with cognitive arousal and not measures of pain severity. Thus, the use of a global measure of sleep quality obscured our ability to resolve how pain intensity was related to specific aspects of sleep continuity problems.

Second, in the present study, we used prospective (daily diaries) measures of sleep disturbance. In general, prospective measurement is likely to yield more reliable assessments given multiple sampling. Increased reliability, in turn, would be expected to enhance our ability to detect smaller effects. The use of prospective measures may have also directly allowed for increased experimental sensitivity. A preliminary study by our group, for example, found that patients with primary insomnia tend to underestimate the number and duration of nightly awakenings on retrospective instruments (Cragg *et al.*, 1999). The use of sleep diaries, therefore, may have increased our power to detect effects that were specifically related to wake after sleep onset time. Finally, in the present study, we also used prospective measures for our pain severity assessments. Here again, prospective measurement improves reliability of measurement given multiple sampling and this would be expected to enhance our ability to detect effects that are related to pain severity.

Depression Severity and Sleep Continuity

Interestingly, in the present study, we did not find depressive symptom severity to have a significant relationship with sleep continuity as some previous work suggests (e.g., Atkinson *et al.*, 1988; Haythornthwaite *et al.*, 1991). The findings of the present study are, however, consistent with studies by Morin *et al.* (1990) and Wilson *et al.* (1998), which found that sleep disturbance in pain patient populations may not always be associated with underlying mood disturbance. The apparent inconsistency in the literature might be understood as an artifact of distinct measurement strategies. For example, one-shot, global, retrospective measures of sleep compared with daily sleep diaries and objective measurement (e.g., actigraphy or polysomnography) may yield distinct patterns of associations with depression severity. This may be because each strategy, although related, captures different and equally valuable dimensions of sleep behavior. This points to the need to utilize multiple measurement strategies in future research (Wilson *et al.*, 1998). In addition to this issue, it may be that depression severity is more intimately

related to specific dimensions of sleep continuity and sleep quality not addressed in the current multivariate analysis. The bivariate analysis, in the current study, for example, found depression severity to be positively associated with a longer duration of early morning awakenings. Continued work is needed to clarify the complex relationship among pain, cognitive arousal, and depression.

Clinical Implications

The results of this study may be interpreted to suggest that primary insomnia and the insomnia that occurs in patients with chronic pain may be more similar than different. One could argue that in both clinical entities sleep continuity problems may be related to cognitive arousal and/or increased sensory and information processing. If this is true, analgesic therapies alone may not be the optimal strategy for treating insomnia in chronic pain patients. Instead, standard cognitive-behavioral treatments for insomnia may be quite useful and effective adjuvants. In support of this position, a preliminary study by Morin and colleagues (1989) using stimulus control (Bootzin, 1972) and sleep restriction (Spielman *et al.*, 1987b) procedures found that chronic pain patients made significant improvements in sleep quality and mood, which were maintained at a 6-month follow-up. In addition to these standardized and empirically validated interventions (Morin *et al.*, 1994; Murtagh and Greenwood, 1995), it may be useful to develop a cognitive approach that targets the kind of ruminative worry identified in the present study.

Concluding Remarks

This study highlights the need for more focused research on the complex relationship among sleep quality, cognition, depression, and pain-related variables. Several directions are possible. First, it will be improtant to replicate and extend the present findings in a study that includes relevant comparison groups [e.g., patients with primary insomnia, patients with another form of secondary insomnia (e.g., patients with insomnia secondary to major depression), and good sleeper controls] and objective measures of sleep (e.g., polysomnography and/or actigraphy). Such a study could more definitively establish the central role of cognitive arousal and demonstrate that while this represents a common factor, thought content varies by diagnostic category. Second, treatment intervention studies could be undertaken that not only evaluate the effects of targeted treatment for insomnia in patients with chronic pain, but also evaluate the effects of insomnia treatment on pain perception and quality of life. Treatment intervention studies could also be used

to assess further the importance of cognitive arousal in insomnia secondary to chronic pain. That is, with effective treatment for insomnia one would expect measures of cognitive arousal to change in parallel with clinical gains. Third, additional research that utilizes the thought sampling procedure to investigate the cognitions during night time awakening episodes may clarify the role of environmental stimuli and other pain-related factors as a source of sleep maintenance difficulties. Positive findings within these domains hold the promise of reducing the personal and socioeconomic consequences of chronic pain.

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